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E. W. HILGARD, DIRECTOR

OLIVES

BY
F. T. BIOLETTI AND GEO. E. COLBY

MISSION OLIVE OF CALIFORNIA (SINGLE OLIVE NATURAL SIZE)

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OLIVES

CULTIVATION, OIL-MAKING, PICKLING, DISEASES

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VARIETIES AND THEIR ADAPTATION

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CULTIVATION, OIL-MAKING, PICKLING, DISEASES.

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Nearly all of the publications of this station relating to olives and olive-growing having been destroyed in the burning of the Agricultural Building, there are none now available for distribution. The present bulletin, therefore, has been prepared in answer to the numerous inquiries that are continually received. It is not intended as a manual of olive-growing but only as a convenient summary, covering the main points about which inquiries have been received.

Cultivation.

Climate.—The olive is a native of Southern Europe and has been cultivated in nearly all the countries surrounding the Mediterranean from time immemorial. From there it has spread to various countries which offer, like California, similar climatic conditions. It requires an average yearly temperature somewhat higher than is required by the vine, and will not withstand so low a temperature as the latter. It is dangerous to plant olive trees in any region where the temperature often falls below 20° F. Some varieties will withstand 15° F., but only for a short time; and the young wood of many varieties is injured even above this temperature. At 10° F. the whole tree is destroyed. In spring, after the new growth has started, much less cold than the above is harmful. On account of its need of an even climate the olive is seldom cultivated successfully more than one hundred miles from the sea, and succeeds best where the mean temperature of the coldest month does not fall below 43° F.

Soil.—The olive needs a light, well-drained soil, and either does not succeed, or gives fruit of poor quality, on heavy, clayey, or ill-drained soils. It is especially suited to sandy or loam soils rich in lime, and will grow in soils so rocky that nothing else but a vine could succeed in them. It is a mistake, however, to suppose that the olive will give profitable crops in poor soils; such soils must be well fertilized to insure good growth of the young trees and good crops on the old.

The olive requires less water than most cultivated trees, on account of its light foliage, and of its strong root system which penetrates to a

great depth even in very rocky subsoils, if well drained. Where the rainfall is very light, however, irrigation is necessary. It must not be excessive, and the water level must be kept low, otherwise the quality of the crop will be inferior and the trees more subject to disease.

Propagation.—Olives are generally propagated by cuttings. There are several different methods, but the following probably gives the best results:—Young shoots, several inches long, are cut from strong, vigorous trees with a sharp knife. They should be cut as soon as their wood is fairly well hardened, but not too late in the season; and all the leaves should be removed, except two or three at the top. They should be planted immediately in shallow boxes of sand, placed in a greenhouse or a warm shady place and kept moderately moist. In three or four months most of them will be well rooted, and should be transplanted to pots or to a nursery where they will receive more sun. Here they should remain for three or four months longer and are then ready to be planted in place. It is best not to plant them too early in the spring, before the soil has been well warmed; and care must be taken during the first year that they do not dry out.

An olive orchard may be brought into bearing a year earlier by using larger cuttings of old wood, but the trees are seldom so strong and are much more uneven than by the foregoing method. The cuttings or truncheons in this case are taken in December or January from branches two or three inches thick, and are cut about twenty to thirty inches long. They should be made only from strong healthy wood with sound bark. They should be cut so that they have knots at the base, as this favors the production of roots. Great care should be taken not to bruise them, and all the shoots should be removed, except a few at the top. They should then be planted in a nursery of very light sandy soil, being buried about two-thirds of their length and the soil tightly packed around them. The top ends of the cuttings should be coated with pitch, and, if the weather is hot or dry, the nursery should be shaded until the cuttings begin to throw out shoots. A very thorough watering should be given the ground immediately after planting, and the soil must never be allowed to get dry until the cuttings are well rooted. A certain portion of the cuttings will fail to grow with the best of care, and many will remain dormant for one or two years. Those which grow well, however, are ready for planting-out in the orchard the following season.

Another method commonly practiced is to cut sections of large branches one or two feet long, split them in two and then to bury the halves horizontally, with the bark up, about three inches deep in the nursery. If the soil of the nursery is warm, light and well drained and kept rather moist, a large number of shoots will in a few months start from the buried sections and come through the soil. When these shoots have become firm, but are still growing, they are cut off, with a sharp knife, as close as possible to the old wood and planted in the same manner as described above for the young shoots taken directly from the trees.

One of the commonest methods of propagation, used especially in Italy, is by means of "uovoli". This is the name given to the knot-like swellings that occur very plentifully on the trunk of many

varieties, especially near the base, and on the exposed parts of the main roots. They are masses of dormant buds, and receive their name from their resemblance in shape, after removal, to eggs. They should be cut out carefully, and the places from which they are removed painted over with pitch. They are generally removed in November, and in frostless localities may be planted immediately. If necesssary, they may be kept for three or four months in a dark cool place, buried in sand and planted in the nursery when danger of frost is past. The "uovoli" are planted three or four inches deep in a sandy soil, and of the many shoots which start from each, only the strongest is allowed to grow. They are ready to plant out in place in two or three years. This method of propagation, at one time common, is being gradually abandoned, as, besides injuring the trees from which the "uovoli" are taken, it results in poorly rooted, short-lived trees, which are inordinately prone to produce suckers.

The strongest, heaviest-bearing, and longest-lived trees are those grown from seed. Seedlings have a stronger and more deep-seated root system, and grow into more regular and more hardy trees than those grown from cuttings. The only objection to their use is that they require several years longer time before commencing to bear. With care and intelligent cultivation however this delay can be reduced to one or two years, and the larger crops and healthier trees resulting, will more than compensate ultimately for the loss of time.

The flesh of the olive should be removed before planting the pits. This is commonly done by piling the fruit in heaps and allowing it to decay, after which the pits can be easily removed by washing. Many of the seeds of most varieties will not germinate. These are separated by placing all the pits in water and rejecting those which float. The pits may be planted immediately, or if there is danger of frost, kept in dry sand until spring. The pits must be cracked before sowing, or they will remain two years in the ground before germinating. This must be done very carefully, in order not to injure the kernel; special instruments have been made for this purpose which work very well. Instead of cracking the pits they may be placed for twenty-four hours in a lye solution containing half a pound of caustic soda to one gallon of water. This softens the shell so that it soon decays in the soil and allows the young seedling to push through. The pits should then be sown in a sandy bed heavily fertilized with thoroughly rotted manure. They are placed every three inches in little drills which are made six inches apart. Enough well rotted manure should be placed in the drills to cover and surround the pits, and the whole covered with soil to the depth of one inch. The beds should be well watered until the seedlings start; after which less water should be used. When the seedlings have developed five or six leaves they should be transplanted to the nursery, the roots at the same time being cut back to about half their length. The olive, like all evergreen trees, is likely to suffer from transplanting, unless care is taken to remove the young plant with an adhering ball of earth. This is facilitated by the manure which is placed around the seed when planted.

The seedlings always revert more or less to the wild plant or type; so that it is necessary to graft or bud them with the variety which it

is desired to propagate. This may, in very favorable cases, be done the spring after planting, but usually they are not large enough until after the second spring. Two-year-old wood should be used for grafting, and the grafts put in at the neck of the roots, just below the surface of the ground.

The ordinary wedge-graft is usually used, and the union should be carefully tied up and covered with grafting wax. The soil is then piled up around the graft until only two eyes are exposed. If the seedlings are large and have thick bark they may be budded in the stem just above the ground. One year after grafting or budding, the trees are ready for planting-out in their permanent places in the orchard.

It is customary to leave the young trees for several years in the nursery before planting them out, but as an old plant suffers from transplanting much more than a young one, it is much better to do it earlier. The greatest attention, however, must be given to the young trees for the first few years. They should be thoroughly cultivated, manured, and whenever necessary, watered.

Pruning.—Though olive trees are grown in some districts without pruning, there can be no doubt that intelligent pruning increases the regularity, quantity, and quality of the crop. Heavy pruning at intervals of several years is practiced very commonly, but results in irregular bearing and renders the trees more susceptible to disease. The system which gives the best results from all points of view is a moderate pruning every year. Two main objects should be kept in view in pruning: 1. To give the tree the most convenient form. 2. To cause it to produce as large a crop each year as is consistent with the quality of the fruit and the health of the tree.

For the smallest-growing varieties the tree should branch out about 3 feet from the soil, and should be given a spherical bush-like top. For the stronger and larger growers the trunk should be 4 or 5 feet high, and the branches should grow in "goblet" form. The object is to give every part of the tree, as nearly as possible, an equal amount of air and light, and to give it the form that best facilitates gathering the crop. It should always be kept in mind that any part that is unduly shaded will fail to produce fruit.

All the fruit of the olive is borne on two-year-old wood, and the same wood never bears twice. That is, the crop of this year is borne on the shoots that grew last year, and the next year's crop will be borne on the shoots that develop this year. For this reason a new crop of shoots each year is essential to regular bearing.

The art of pruning can be learned only by practice and experience; but it will be found useful to keep the following points in mind: Cut away all dead or diseased twigs or branches; thin out wherever the branches are too close; cut back the branches that tend to grow too long, in order to make them send out side shoots for fruiting wood. It should also be kept in mind that heavy pruning confines the sap to fewer outlets, and results in the production of vigorous sterile or wood-bearing shoots; while light pruning, leaving a larger number of buds, results in a large number of weaker and more fertile shoots. A tree, therefore, which has sent out an inordinate number of sterile

shoots, should not be cut back much, while a tree that has been enfeebled by too large a crop must be heavily pruned.

When a tree has been properly pruned from the beginning, it is seldom necessary to remove anything but small twigs, or to make large wounds. When, however, on account of improper pruning, or of great age of the tree, all the main branches of the tree have become bare, and all the fruit-bearing wood has disappeared from the center of the tree, it is necessary to cut back even the largest branches. This, however, should be done gradually, or the tree will be injured by a too sudden curtailment of the leaves which are its feeding organs. A heavy pruning should be given the first year, sufficient to force out shoots from the lower parts of the branches. The next year the most vigorous and best situated of these shoots should be chosen to replace the old branches, and the latter cut back still further. A branch of any size should not be cut back too close to the old wood, even when it is intended to suppress it completely, as there is danger of injury to the main branches or trunk by drying out of the wood. Whenever a large cut is made, for any reason, it should be painted over with pitch, or some similar substance, to diminish evaporation and to prevent the growth of fungi.

Grafting and Budding—It has already been stated that when an olive tree is raised from seed, it reverts more or less to the wild form, and produces fruit which is generally unsuited for either oil-making or pickling. To have the desired quality of fruit, therefore, it must be grafted or budded with a better variety. The method of doing this with young trees has already been described under the head of propagation. The olive may be grafted by almost any of the methods used for other fruit trees; but they are not to be recommended except when, as in the case of young seedlings, the graft can be made below the surface of the ground. For large trees, when it is desired to change the variety, budding is to be preferred.

Budding succeeds well if done at the right time and under the proper conditions. The essential points are that the bud must be taken from good healthy wood, and inserted in a vigorous shoot. Most of the failures in budding result from using a shoot of low vitality as a stock. In order to insure shoots of sufficient vigor to start a bud, the tree which is to be budded should be pruned severely the year before. If the tree is large it is advisable to cut back only half the branches the first year. The following spring the pruned branches will send out a number of vigorous shoots, the best of which may be budded. The following winter the rest of the branches should be cut back and the budding completed the second summer. In this way the tree does not receive so rude a shock as if all the branches were cut back the same year.

The ordinary T-bud succeeds very well on the olive, though some prefer the shield-bud. For the scion a dormant bud in the axil of a leaf may be taken, as is usually done for other plants. With the olive, however, twig-buds are more successful. The twig-bud is cut from the parent plant as shown in Fig. 1. It must be cut deeply with a sharp knife and part of the wood removed before insertion in the stock. Also about two-thirds of each leaf on the twig-bud should be

cut off to prevent drying out by too much evaporation. The bud is inserted in the usual way as shown in Fig. 2, and tied by winding a

FIG. 1.—TWIG-BUD AS CUT.

FIG. 2.—TWIG-BUD INSERTED. (Dotted lines show manner of tying.)

cotton string tightly around the stock both above and below the bud so as to cover up all the cut parts. Three or four weeks later the string should be removed and the stock topped. If the union has been effected the bud can be left to itself, simply cutting off the whole of the stock above the bud as soon as the latter has developed sufficient leaves.

Budding may be done at any time when the sap is flowing freely, but is most successful if done in the early summer or spring. If done too late the buds fail to start until the following spring, and are apt to dry out.

Gathering the Fruit.

Picking Olives.—Whether olives are to be used for pickling or oil-making, it is very important that they should be picked carefully and at the right time. For green pickles they should be picked very soon after they obtain full size, but before they have begun to color or soften.

For ripe pickles they should be gathered at the same stage of ripeness as for oil-making; that is, when they contain the maximum amount of oil. This is soon after they are well colored, but before they have attained the deep black which signifies over-ripeness. If the olives are gathered too green the oil will be bitter, if too ripe it will be rancid. On account of the different degrees of color in different varieties of olives, it is difficult to tell from their appearance when they should be gathered. When they can be easily shaken from the tree they are ripe enough. If they commence to fall without vigorous shaking they are over-ripe. For whatever purpose the olives are to be used they should be carefully gathered by hand. Rakes or sticks should never be used, as they bruise the fruit and break off a great deal of the fruit-shoots needed for the following year. It is well to sort the olives as they are being picked, separating out the bruised, diseased,

or under-ripe fruit. When the olives are for oil-making they should be washed before being crushed or dried, unless they are very clean, for the road dust and sooty mold that often covers them have a deleterious effect on the quality of the oil.

Oil-Making.

Drying and Crushing.—The best oil is made by crushing the carefully-picked olives as soon as possible after they are taken from the tree, and while they are still perfectly fresh. If they are bruised, or if they are in the slightest degree moldy when crushed, the resulting oil will be correspondingly inferior in quality.

The extraction of oil from fresh olives is, however, somewhat troublesome, and in order to facilitate the work it is customary to deprive them of a certain part of their water before crushing. This partial drying is also useful when it is necessary to keep the fruit for some time before crushing or to ship them to any distance. It is generally done by placing them in layers not more than three inches deep, on trays that are stacked in a dry, well-aired room, protected from the wind and the direct rays of the sun. The olives are turned over daily until they become well wrinkled. This requires about eight or ten days, according to the degree of temperature. If the partially dried fruit cannot then be crushed immediately, it must be stored in a dark room where the temperature does not rise above 60° F. Here it may remain three or four weeks longer without any serious deterioration of the quality of the oil. In order to hasten the drying process, artificial driers, constructed on the same principle as the fruit or hop driers, are sometimes used. The olives are placed in a single layer upon trays, and the drier is kept at a temperature of about 120° F. If the temperature rises over 130° F. the quality of the oil will be impaired. The drying takes about forty-eight hours—more or less—according to the nature of the fruit. The olives must be crushed immediately upon removal from the drier.

The crushing is still commonly done by means of old-fashioned stone mills. They are slow, cumbersome, and irregular in their action. Moreover, almost all kinds of stone that are used for these mills absorb a certain amount of oil, which it is impossible to remove completely. This oil becomes rancid and taints the olives that are being crushed. Crushers, with corrugated bronze or bronzed metal rollers, are now made that perform their work in a very satisfactory manner, breaking up the flesh and pits very thoroughly. As they are all of metal they absorb no oil and are easily cleaned. It is very essential that the flesh should be crushed thoroughly in order to break up the cells and permit the oil to be pressed out.

Some oil-makers prefer to pit the olives before crushing, in order to separate the oil in the flesh from that in the pit. Machines for this purpose have been made, but are little used. The amount of oil contained in the pit is very slight, and is inferior in quality to that in the flesh, as it is much more prone to become rancid. Many varieties, notably the Mission, contain a particularly minute quantity of oil in the pits, and, as luckily a very small proportion even of this minute quantity can be expressed, there is little danger, usually, in crushing the pits and flesh together. No method, moreover, seems to have

been devised as yet that will at one operation sufficiently crush the flesh while leaving the pit intact.

Pressing.—As soon as the olives have passed through the mill or crusher they should be pressed. For this purpose an extremely powerful screw or hydraulic press is necessary. Fig. 3 shows one that has been used with success at the Experiment Station. The mass of crushed olives should be placed in the press in such a manner that it will constitute a series of layers, each of which can drain off horizontally as the pressure is supplied. This is accomplished, among other ways, by means of wooden gratings and pieces of very strong cloth, or sacking, placed between the layers. Circular grass mats, used extensively in Europe, are very convenient, but as yet too expensive in California. The pressure must be applied very gradually. From the liquid which runs out first, with gentle pressure, is made the very finest oil, known as "virgin oil." The pressure is then increased very gradually until the full power of the machine is reached. This presses out the second quality of oil which is generally mixed with the first. After obtaining all the oil possible by the first pressure, the "cheese" is taken out, thoroughly broken up in hot water, and again pressed. This yields the third quality, which is very much inferior to the first and second. Sometimes the "cheese" from the first pressing is thoroughly broken up with cold water and pressed again before being treated with hot water. In this way a little oil is obtained that differs little from the second quality, and may be mixed with it. After this, a certain amount of oil still remains in the "cheese," but it can be extracted only by very powerful hydraulic presses, or by chemical means, and is then of very inferior quality and suitable only for burning or for soap-making.

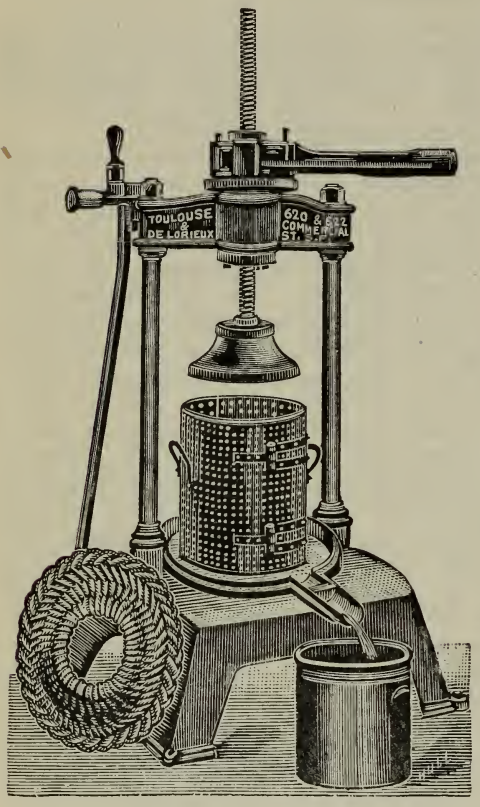

Fig. 3.—Oil Press.

Separation of the Oil.—The liquid that runs from the press contains, besides the oil, the watery juices of the fruit and a considerable amount

of pulpy solid matter. The separation of the oil is usually effected by allowing the press-liquid to settle in tinned vessels until the oil, rising to the top, can be skimmed off. The use of the apparatus shown in Fig. 4 is a great improvement over this method. It makes the

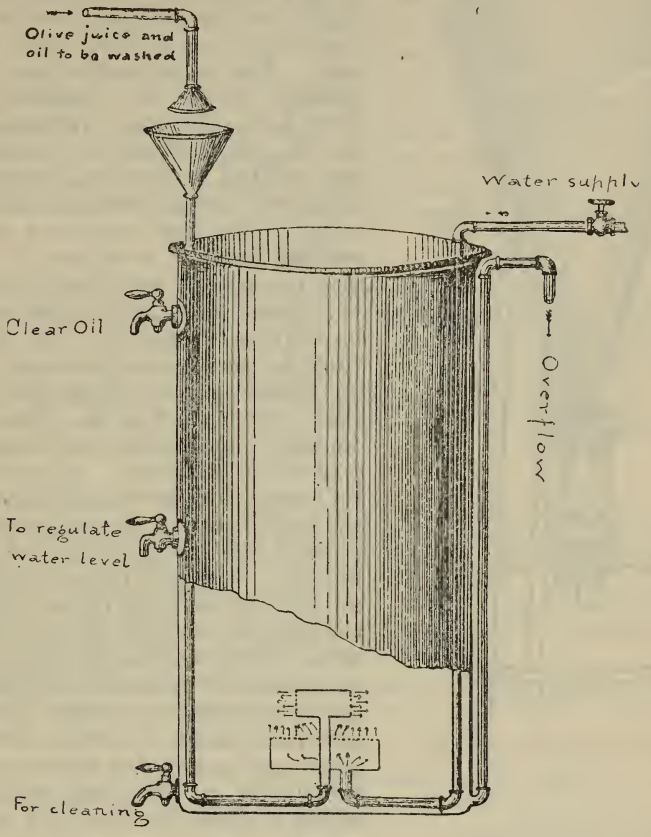

Fig. 4.—Oil Separator.

separation of the oil almost instantaneous, and improves the quality by doing away with the prolonged contact of the oil with the air and the impurities of the liquid. The juices from the press flow into a tube, which opens into a small "drum" near the bottom of the tank which is kept constantly full of water. The drum is perforated at the sides in order to allow the press-liquid to escape horizontally. Immediately below this drum is another larger one, perforated on top, through which water is forced in vertical jets. The water and press-liquid are thus thoroughly mixed in constant agitation. This results in the rapid deposition of the heavy impurities, and the equally rapid rise of the small, light oil-drops. The oil very quickly forms a layer on top and can be drawn off by means of a faucet appropriately placed. The apparatus is continuous in its operation, and the oil is obtained free from all the grosser impurities. It is still, however, very cloudy, owing to the presence of small, light particles of vegetable matter.

Clarification.—The oil must be made as bright as possible before being put upon the market. This can be done by various methods of filtration. Filtration, however, diminishes the freshness and aroma of the oil and injures the qualities that distinguish a fine olive oil from the clear, neutral oils extracted from cottonseed. This is especially true of such filtering media as charcoal, which exert some absorbent influence upon the oil, diminishing its flavor. The best method of clearing, for oil as for wine, is by simple settling and decantation. For this purpose a series of settling tanks is made use of. These may be made of well-tinned metal, or of cement lined with glass or other impervious substance. The first settling is conveniently made by means of a funnel-shaped apparatus such as that shown in Fig. 5. The steeply conical shape facilitates the rapid deposition of sediment. After standing for twenty-four hours in this apparatus the major part of the sediment is deposited and can be drawn off at the bottom. It is well, before running the oil into the settling tanks, to pass it through two or three inches of cotton wool. This is accomplished by means of a funnel with a perforated, horizontal cross-partition, upon which the cotton is placed. It takes, generally, about one month for the oil to settle sufficiently in the first tank, after which it should be drawn off carefully into the second, and so on until it is sufficiently bright. Three rackings are usually sufficient, and if all parts of the process have been well attended to, an oil is obtained almost as bright as can be produced by the most effective method of filtration, and having, besides, the agreeable and distinctive olive flavor and absence of greasiness which is lacking in all filtered oils.

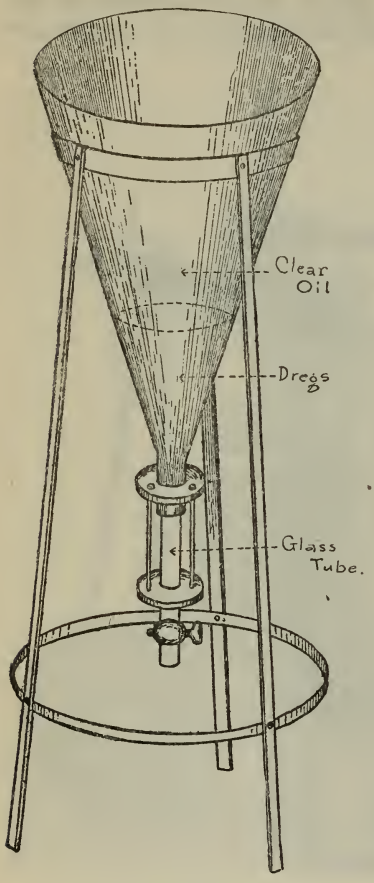

Fig. 5.—Oil Funnel.

Precautions.—The best oil can be made only from the cleanest and soundest olives. The most thorough cleanliness must be observed in all operations. Olive oil is particularly susceptible to bad odors, and the presence of a smoky lamp or stove, or of tobacco smoke, will certainly communicate a corresponding taste to the oil. Air and light must be excluded from it as much as possible, as they favor the oxidation which is the cause of rancidity. Contact with wood, cloth or any materials of an absorbent nature should be avoided as much as possible,

as it is extremely difficult to free them from the oil which they absorb. This finally becomes rancid, and the taint is communicated to the good oil. For the same reason no oil should be allowed to remain on any part of the work room, and the free use of boiling water and soda, whenever oil is spilled, is essential. Iron has an injurious effect, especially on the unclarified oil, and all iron utensils should be well tinned. It is also very necessary to preserve an even and proper temperature in the press and storage rooms. If the temperature is too low the oil becomes too thick, and at very low temperatures it solidifies; this makes it impossible to handle or clear it. If the temperature is too high, oxidation is facilitated. The temperature should, therefore, not be allowed to fall below 50 F. nor to rise above 65 F. and should be kept as even as possible. Water used must be free from all taint.

Pickling.

The successful production of pickled olives is a matter of experience and depends almost altogether on the individual judgment and skill of the producer. No method can be given which is suitable to all cases, and the best method must be modified according to the nature of the olives to be treated. The following scheme, therefore, is to be considered as a mere outline, to be carefully adapted and modified by the operator at each stage of the process.

Lye Process.—1. Place the olives in a solution, composed of two ounces of potash lye to one gallon of water, for four hours. Repeat this once, or twice *if necessary*, to sufficiently remove the tartness.

2.* Rinse the olives thoroughly and replace the lye solution with fresh water. Change the water twice a day, until the potash has been removed from the olive, as judged by the taste.

3. Replace the water with brine composed of four ounces of salt to a gallon of water and allowed to stand two days.

4. Put in brine of six ounces of salt to a gallon for seven days.

5. Put in brine of ten ounces per gallon for two weeks.

6. Put finally into a brine containing fourteen ounces of salt to the gallon of water.

In order to make this process a success the following considerations should be kept in view:

1. Great care should be taken not to allow the olives to come in contact with anything that will injure their flavor. The vats or other receptacles used for pickling should be perfectly clean, odorless, and tasteless. Earthenware is the best material, but it is usually cheaper and more convenient to use wooden receptacles thoroughly treated with boiling water and soda until they are sterilized and all taste of the wood removed. Any wood (such as pine) with strong taste should not be used. The vats should be provided with a removable wooden grating, fastened one or two inches from the bottom, and a close fitting floating wooden cover to prevent access of air, which spots the fruit. On top of the vats should be placed a cover of thick cloth or of wood

* Professor Hilgard recommends the use of weak brine from the first, that is as soon as the lye solution is removed.

to exclude light and dust. Each vat should be provided at the bottom with a wooden spigot for drawing off the solutions.

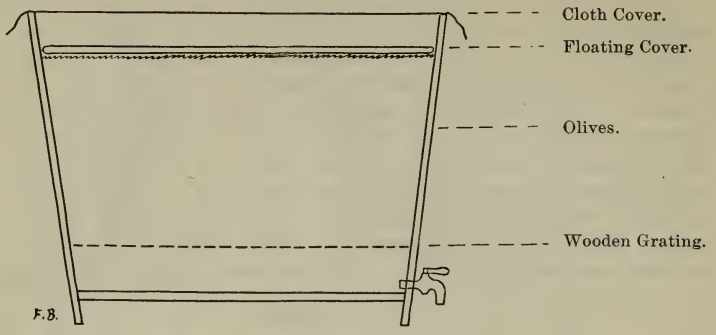

FIG. 6.—PICKLING VAT.

The thickness of the layer of olives should not be more than two feet, or less with soft varieties.

2. Only the very best of potash lye should be used. Some of the brands of lye are so impure that it is impossible, without a chemical analysis, to tell within forty per cent. how strong the lye solution actually is when made up. "Greenbank Lye" has been found the most reliable, and may be considered as one hundred per cent. pure when making up the solution. The length of time which the olives should be left in the lye, and the number of times the lye should be renewed, can only be determined by experiment for each variety and each locality. The object is to extract the tartness of the olive, and at the same time to soften the skin sufficiently to allow the tart or bitter substances to be soaked out in the subsequent treatment with pure water. The tougher and thicker the skin of the olive and the more intense the tartness, the longer must the lye treatment be continued. The lye is sometimes made twice as strong as recommended above, and the treatment correspondingly shorter, but the results are not so good. Just enough lye solution should be used to exactly cover the olives, and occasionally, during the soaking, some of the solution should be drawn off below and poured on top to insure an equal treatment of all the fruit.

3. Only the very purest water should be used, both for the lye solution and for the subsequent soaking. Canal and river water, or any water that contains a great deal of organic matter, should never be used unless it is practicable to boil it first. Distilled water, such as can sometimes be obtained by condensing the waste steam from a boiler, is the best, both on account of its purity and its greater extractive power, provided of course it be free from oily flavors. The length of time during which the soaking in pure water should be continued, varies very much in accordance with the character of the fruit. If the olives are firm and show no signs of becoming soft it should continue until the tartness is sufficiently extracted. This will vary usually between ten and twenty days. The moment that the olives begin to show signs of softening, however, they should be placed in weak brine, even though the tartness has not all disappeared.

What remains can then be extracted by the brine, which should be changed two or three times, as may be necessary. It is not necessary to change the brine quite so often as the pure water, once in two days being generally sufficient.

If the olives are soft at first, before treatment with lye, or if they are of a kind that softens rapidly in the lye, it is necessary to use brine from the beginning, either immediately after treatment with lye or, in extreme cases with the lye. This method, suggested by Professor Hilgard, has been used with marked success. The lye solution in this case should be made by adding two ounces of lye and four ounces of salt to each gallon of water. As the lye acts much more slowly when used in combination with salt, it may be allowed to stay on the olives for a longer time without injury, eight to twelve hours or even more. In this way the lye solution tends to soften and swell the olives, the brine counteracts this and tends to harden and shrink them. The shrinkage, which occurs when brine is used from the beginning on naturally soft olives, is not a disadvantage if not carried too far, as such olives are generally too watery to be palatable or to keep well. They can, moreover, if shrunk too much, be made plump again by a few treatments with pure water before being put finally into brine.

The first salting must be done very gradually and carefully in order to prevent shrinkage and wrinkling of the fruit. For this reason, gradually increasing strengths of brine must be used, as described, and the olives left long enongh in each to be thoroughly penetrated.

In all these operations no sign of scum or slime should be allowed to accumulate on the olives, the vats or the covers. This is of especial importance during the treatment with plain water. On the first signs of sliminess around the sides of the vats, where it appears first, they should be emptied and thoroughly brushed and scalded before replacing the olives.

Pure-Water Process.—The best pickled olives are made without the use of lye, but this process is only practicable with olives whose tartness is easily extracted, and where the water is extremely pure and plentiful, and even then it is very slow and tedious. It differs from the last process only in omitting the preliminary lye treatment. The olives are placed from the beginning in pure water, which is changed twice a day until the bitterness is sufficiently extracted. This requires from forty to sixty days or more. The extraction is sometimes hastened by making two or three shallow, longitudinal slits in each olive, but this modification, besides requiring a large amount of expensive handling, renders the fruit peculiarly susceptible to bacterial decay and softening. Altogether, the pure-water-process cannot be recommended for California, as it is too expensive and uncertain.

Green Pickles.—Green pickled olives are made by essentially the same processes as are used for ripe pickles. The extraction of the tartness requires the same care and the same close adaptation to peculiarities of different varieties as already described. The olives are pickled soon after they have attained full size, and before they

have shown any signs of coloring or softening. They contain at this time comparatively little oil, and are in every way much inferior to the ripe pickles in nutritive value. They are not a food but a relish. They are rather more easily made than the ripe pickles, as there is less danger of spoiling. There is, however, very little market for any but the largest sizes.

Nutritive Value of Olives.—Pickled *ripe olives* constitute an extremely nutritious and digestible form of food. They contain a large amount of oil, carbohydrates and some nitrogenous matter, and in some countries replace meat to a certain extent. Pickled *green olives* such as those imported from Spain are on the contrary indigestible and contain much less nutriment. They are made from unripe fruit and are therefore, as far as their use as food is concerned, in no way superior to unripe apples or peaches. They are simply a relish and to be used in very limited quantities, in the same way as pickled walnuts or cucumbers. A meal of bread and ripe olives is not only palatable but nutritious and sustaining, and the amount eaten is to be limited only by the same considerations as that of any other good wholesome food.

The following table of analyses, prepared by Professor Jaffa of this Station, illustrates very forcibly the superiority of ripe pickles over green ones in nutritive value.

Analyses of Edible Part of Ripe and of Green Pickles.

	Ripe Pickled Olives from California.			Queen Olives (green) From Spain.
	Medium-sized Mission.		Larger, Watery Mission.	
Water, per cent.	64.72	65.45	72.77	78.41
Oil, per cent.	25.89	25.15	18.81	12.90
Carbohydrates, per cent.	4.28	3.22	2.49	1.78
Other matters, per cent.	5.11	6.18	5.93	6.91

The Queen olives were the best of their kind to be found on the market, and when compared with the first two samples of ripe pickles, which are typical of good ripe Missions, show just half the amount of nutritive material. This does not show the whole difference, for there is no doubt that the nutriment in the ripe fruit is in a much more readily assimilable form than in the green. The third sample was grown on an over-irrigated soil, and while inferior to the first two, is much superior to the green fruit both in quantity and quality of nutriment.

Grading and Sorting.—It is extremely important that all the olives in each lot of pickles should be as nearly as possible uniform in character, in order to facilitate the process of pickling and to produce an attractive appearance. Olives of different varieties, and even those of the same variety from dissimilar locations, should never be mixed. The first sorting is done while gathering, and the under-ripe, over-ripe and injured fruit separated from that which is to be pickled. The

good fruit is then graded by means of a mechanical grader according to size. In this way the olives are separated into different lots which will each contain fruit on which the different processes of pickling will act uniformly. A grader adapted to handling soft fruit, that will not bruise the olives, must be used. That represented by Fig. 7 has been used successfully. After the pickling process is finished there will often be a distinct difference of color between different olives of the same lot. Another sorting according to color is then advisable. This must be done by hand, and either two or three colors may be separated, dark and light or black, medium and greenish according to the variety.

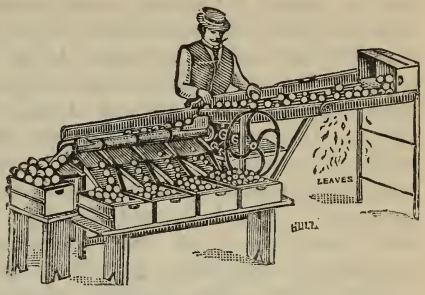

FIG. 7.—OLIVE GRADER.

Diseases.

Both the olive tree and its fruit are subject to a large number of diseases in Europe. Luckily most of these, and some of the most destructive, have not yet appeared in California. In this bulletin only those which have assumed some importance in the State are described.

Twig Borer.—The small black or brown insect which bores into the small branches of the olive at the base of a bud or twig is a beetle called *Polycaon confertus*. No method of extermination has been devised, but luckily it seldom does any great damage. As the twigs which are attacked are weakened, they should be removed at time of pruning and burned. This will prevent the waste of nourishment on weakened twigs, and destroy any borers that remain in the holes.

Black Scale.—Although other varieties of scale insects are occasionally found upon the olive, the black scale is the only one that does serious damage, and is, in fact, the worst enemy of the olive tree in California. The injury done by the insect is due to the extraction of nourishment and water, and, when the insects are plentiful, to the "hide-bound" condition of the tree that ensues, preventing the proper growth and assimilation of food materials. A secondary injury is due to the growth of fungi, induced by the presence of the scale. This will be discussed later under *Sooty Mold*. The black scale is most prevalent in the orchards near the coast. The extremely dry air, which occurs occasionally for long periods in the interior valleys, usually prevents it reaching injurious numbers. The black scale has many natural insect enemies, but none of them are capable of repressing it sufficiently when other conditions are favorable to its growth and multiplication.

The small Australian lady-bird *(Rhizobius ventralis)* feeds upon this scale, and was at one time looked upon as a certain remedy wherever it found the proper conditions for its growth and multiplication, *i.e.*, near the coast. At present there is great doubt whether the

diminution of black scale, that seems to have occurred where the *Rhizobius* was first introduced, is really all to be credited to this insect. The black scale is subject to certain fungous and bacterial diseases, which, under favorable conditions, and especially when the insects have become very abundant, often destroy all of the scale present. In this way orchards that have been thoroughly infested by black scale for several years, will become almost entirely free from them for a long time without any treatment at all. The most effective method of combatting this scale is certainly the hydrocyanic acid gas treatment, but it is too expensive. The only remedy that at present seems to be reasonably certain, effective, and economical, is intelligently conducted spraying. The best and cheapest spray for this purpose is a resin-soap wash made of the following ingredients: Resin, 8 pounds; standard caustic soda, 2 pounds; fish oil, 1 pint; water, 40 gallons.

The resin, soda, and fish oil are placed in a closed kettle with just enough water to cover them, and boiled for two hours. This will form a soap which is to be diluted with hot water, in the proportion mentioned, before use. It is best applied warm. Kerosene emulsion is also effective and convenient, but somewhat more expensive.

A regular annual spraying at a stated time is not to be recommended, and is not effective. For the best results the insects must be watched, and whenever the very young insects appear in large numbers on the leaves and stems, the spray should be applied. This is because the young insects are very much easier to kill than those which are mature and possess a hard protecting shell. In some years two or even three sprayings may be necessary, while for other years spraying may be omitted altogether.

Sooty Mold.—The black scale excretes a sticky substance that is excellent food for various kinds of fungi, and particularly for that known as Sooty Mold. This fungus appears as a black coating on the leaves, stems, and fruit. It does not penetrate the tissues of the plant, and therefore does not injure them directly like some fungi. By shutting off the light, however, it interferes with the assimilation of food by the leaves, which takes place only in the presence of full light. Some injury is also done to the appearance of the fruit by the coating of black fungus, and the dirt and fungi adhering to the sticky substance on the olives no doubt has a deleterious effect on the quality of the oil. As the *sooty mold* grows only upon the excretions of the black scale and not upon the substance of the plant, the repression of the scale will result in the disappearance of the mold.

Peacock Leaf Spot.—This disease is caused by a fungus called *Cycloconium oleaginum*, which grows upon the leaves and fruit. It forms spots about one-eighth of an inch in diameter on the leaves, composed of concentric rings of different shades, which give them an appearance resembling the spots on a peacock's tail. On the fruit the spots are smaller and browner. This disease is very prevalent at Berkeley, and has been found in other localities. It usually does little harm, and can be controlled by Bordeaux mixture. It occasionally becomes sufficiently abundant to make the leaves turn yellowish, and injures the appearance of the fruit a little for pickling.

Dry Rot.—Ripe olives are sometimes attacked by a disease which appears as a shriveling and drying-up of one part, generally the apex, but occasionally the stem end. The disease progresses, especially in warm weather, until a large part of the tissue of the olive is destroyed. After the olives are picked and placed in boxes or on trays, especially the former, the disease progresses more rapidly on account of the greater heat and moisture generally present. The Nevadillo seems particularly susceptible to this disease. Keeping the trees clean and well aerated, and in general the means suggested for the Sooty Mold, are the most likely remedies to be used for dry rot. The disease is caused by two species of fungus, an *Alternaria* and a *Macrosporium;* the former is most usually found.

Bacterial Rot.—Certain large, fleshy olives are subject to a disease which attacks the flesh in the immediate vicinity of the pit. Olives attacked by this disease appear at first perfectly healthy, but if they are cut open it will be found that there are black spots in the flesh near the pit. These spots gradually spread until they surround the pit completely, and in the advanced stage of the disease the olive is almost hollow. It is only at this stage that it is possible to tell from the outside that the olive is not sound. Large numbers of bacteria can be found in the decayed tissue, and it is to them that the disease is due, in all probability. The varieties most subject to this disease are the Polymorpha, Macrocarpa, Columbella, and Obliza.

Another disease somewhat resembling this in character and probably in origin, often attacks soft, fleshy olives. It appears first as small depressions on the outside of the fruit resembling the results of bruising. These depressions enlarge in size and finally involve a large part of the fruit. If cut open it will be found that the tissue below the depressions is brown and decayed, but not hollowed out as is the case with the decay last described. Olives attacked by either of these diseases will, of course, give an inferior oil, and are very difficult to pickle. They should be used for pickling as soon as possible after the disease is discovered, and treated by Professor Hilgard's method of combined lye and salt solution. The Manzanillo seems to be particularly susceptible to this disease. As both of these diseases attack principally large, fleshy varieties, and especially very juicy fruit, it is very likely that the methods, especially drainage, recommended for Olive Knot, would be effective in restraining its development.

Olive Knot.—This disease appears as woody tumors on the leaves, branches, stems, and particularly on the small twigs of olive trees of all ages. It is confined to warm localities and especially to rich, overmoist soils. The size of the tumors on the leaves varies from that of a pin-head to that of a pea. On the twigs they are usually about the size of a hazel-nut or walnut. On the main stem they may be large, and they sometimes, especially in the neighborhood of cuts or plough wounds, run together and form large masses of dry, fissured, tumor-like tissue. They are shown in the Plate, on third page of cover, as they appear on the small twigs. The disease is rather slow in its progress, and for one or two years seems to do little damage to the trees. Trees when first attacked may even bear more heavily than

usual. Finally, however, at the end of four or five years, the amount of food material taken up by the knots is so large that the tree suffers from starvation and finally becomes useless. The disease is caused by a certain species of bacterium which commences to grow just under the bark, and lives in the interior of the tumor it produces. It is carried from tree to tree by pruning instruments, also probably by insects which puncture the bark, and perhaps by the wind. It only attacks trees which are vigorous and full of sap. The varieties which are most valuable for their fruit, that is, those most removed from the wild type, are the most subject to attack.

As the disease cannot occur without infection from the special bacterium which causes it, the greatest care should be taken to destroy the bacteria and prevent their being taken from one tree to another. Upon the first appearance of the knots, the twigs on which they appear should be cut off and burnt on the spot; and unless the orchard is naturally well isolated from all others, the whole tree should be destroyed in the same way. No tools used upon an affected tree should be used upon any other until they have been thoroughly disinfected with boiling water. Heavy pruning should be avoided, as it tends to produce a growth of sappy shoots particularly liable to infection. Finally, under-drainage, whenever practicable, is the most effective method of prevention.

OLIVE VARIETIES AND THEIR ADAPTATION.

By Geo. E. Colby.

In the following pages we give a summary of the physical and chemical analyses of some of the more important and fully tested varieties of olives as grown in the several regions of the State, together with notes on some of the rarer (here) or not yet fully tested ones. By different regions of the State is meant partly geographic and partly climatic regions; thus *Sacramento Valley* embraces the region from Chico, the northern (apparently) limit of the olive, to Sacramento; the *Bay region*, all that part of Central California over which the bay climate prevails, including the Santa Clara Valley; the *San Joaquin Valley*, that part of California drained by the San Joaquin River; the *Sierra Foothill region*, the low hilly belt bordering the Sierra Mountains east of the Great Valley, including such localities as Auburn, Jackson, and Amador County generally; the *Southern Coast Range region* includes Santa Barbara, Ventura, and other counties northward; and for the present purpose *Southern California* is made to include all localities from San Fernando to San Diego.

The descriptions given of the olives are taken from the reports of this Station for 1892–3 and 1894–5, the copies of which were destroyed in the fire of 1897.

During the last eight years over seven hundred and forty samples of olives, representing fifty-seven varieties, have been examined here; six hundred and fifty analyses are comprised in the table of averages at the end of this bulletin; sixty to seventy of the remaining samples were received un-named, and their analyses have served the purpose of assisting the interested grower in identifying his fruit; twenty-five specimens were accidentally lost, by fire, before analysis. The detailed results and discussion of this work, up to that relating to the crop of 1897, have been published in the California Experiment Station Reports for the years 1892–96; the forthcoming report, 1897–98, will contain the complete record of analyses to date.

In passing, attention is called to the fact that in this bulletin we deal mostly with facts relating to the size of the fruit, the amount of pit, and amount of oil in the fruit, and *not with the yield* of fruit. This happens because there are at present no sufficiently extensive or accurate data upon the question of yields of fruit by the different varieties.

It will be noted in the table of averages that the amount of oil contained in the pit is comparatively small, even as extracted by chemical

processes. If all of this pit-oil were available and unobjectionable, the actual quantity would not pay for the trouble of extraction; but these very small amounts are disseminated throughout the hard material of the pits, and this renders their expression by mechanical means a problem of no practical interest. Apart from the uselessness of attempting to extract the pit-oil, the kernel imparts a disagreeable taste to the oil of the flesh with which it comes in contact, and impairs its keeping qualities.

Discrepancies noted by the reader between this and earlier publications of this Station relating to the olive, may be explained by the fact that there now exists a broader basis for this later work.

The Mission Olive.

This name designates the variety found growing at the old missions in California. (See title page.) It has long been known that the so-called Mission olive embraced several varieties, or sub-varieties, at least.

Common or Broad-leaved Mission Olive.—This is the commonest form of the Mission olive in California. The fruit is $\frac{13}{16}$ of an inch long by $\frac{10}{16}$ of an inch thick; ovate, oblique—sometimes very much so; the pit straight or slightly curved, $\frac{10}{16}$ of an inch long and $\frac{5}{16}$ of an inch thick. The fruit is very variable in size, single or in clusters of two or more. It ripens late in the coast region, sometimes not until February, but generally in December; while in warmer localities it ripens in November.

Other Mission Varieties.—On the University grounds there are now being studied three apparently distinct varieties of the Mission: (a) Broad-leaved or Common Mission, already described; (b) Narrow-leaved Mission, a variety from L. A. Gould, of Auburn, described as having a somewhat larger fruit than the broad-leaved variety, and a more straggling habit; (c) Early Mission, from A. A. Wheeler, of San Francisco. It is of the Mission type, but ripens much earlier. Whatever may be the difference, these are of the same type.

There have been received at this Station during the last eight years one hundred and twelve samples of the Mission olive from sixty-five different and widely separated localities. The outlying culture-stations of the University have supplied seven samples. A study of the results of the physical and chemical analyses of the Mission may be summarized as follows:

Size of Fruit.—It appears that the Mission, as grown in Southern California (San Fernando to San Diego), is but little larger than that from the Sacramento Valley (Chico to Sacramento), and neither of these regions produces fruit much larger than that coming from the Southern Coast Range localities. For these three regions, it takes on the average, respectively, 100.8, 101.6, and 106.7 to make a pound avoirdupois. In the San Joaquin Valley and the Sierra Foothills, the Mission olive is found to be smaller than the fruit from Northern and Southern California; in the Valley, 117.9; in the Foothills, 113.0 olives are required to weigh a pound. In the Bay region this olive is found to be, on the average, very much smaller than from other parts

of the State, requiring for a pound as many as 135.2 olives, due probably to the prevalence of heavy (adobe) soils. The average of the Mission variety for the whole State is 111.6 per pound.

Precentage of Pit.—The Southern California Mission olive, the largest of all, is found to contain the least waste material or pit content, the average being 15.8 per cent. The next in order are those from San Joaquin Valley and the Southern Coast Range, with respectively, 16.4 and 16.8 per cent. of pit, while the Sacramento Valley Mission olive has an average of 17 per cent. of pit. The Foothill olive with 19.2 per cent. is slightly superior to the Bay fruit with 20.8 per cent. of pit. These figures do not show great variations from the average pit-percentage of all the Missions, which is 17.2 per cent.

Oil in the Flesh.—The oil content of the flesh of the Mission olive from the Bay and Foothills regions is greater by more than 2 per cent. than that yielded by the northern and southern grown fruit, for the Bay Missions contain on the average 24.27, the Foothill 25.67 and the Sacramento and Southern Missions but 21.3 per cent. of oil in the flesh. The Southern Coast Range and San Joaquin Valley Missions both have nearly 23.0 per cent. of oil in the flesh, or about 1.50 per cent. above the average for all.

Oil in the Pit (calculated upon whole fruit).—The Mission olive contains, along with the Manzanillo and the Columbella, less (.60 per cent.) oil in the pit than any other olive variety that has been fully tested. This, together with the fact that little of the pit-oil can be extracted at best, is one reason why the taste of the oil of the Mission variety is not tainted with that of pit-oil. Another reason is that only a small part of the pits of the Mission contain any kernel at all.

Size.—Among the largely-grown varieties (Rubra, Manzanillo, Redding Picholine, Nevadillo Blanco, Mission, Uvaria, Pendulina, Oblonga and Columbella) which constitute the chief part of the olive orchards of California, the Mission is shown in the table of averages to stand second in size, and to be only slightly inferior to the Manzanillo, which has the largest sized fruit. Again, among these varieties it holds an intermediate position in size of pit; and in the oil content of the flesh, it is superior to most of them and nearly equal to the highest oil producer, the Nevadillo Blanco.

These results emphasize the commonly accepted opinion that this variety is well suited either for pickling or for oil-making, and that it is, in all the different regions of the State, a good "all around" variety, safe to plant, especially upon new and untried lands. It produces an oil of good quality which keeps well, and is also well adapted to pickling; a combination of qualities that further recommends it to the grower.

Nevadillo Blanco, or Moiral.

The Nevadillo Blanco came to California from Spain; probably there are importations from other countries also. From the descriptions we have, we are led to suppose that it is more vigorous and

productive in California than in Europe. But it is first to suffer from frost.

The tree is a vigorous, large, spreading grower; the bark, gray; suckers, ordinarily numerous; foliage, when young, very vigorous, inserted at an acute angle; color, at first dirty greenish gray on the two-year-old wood; wood, cylindrical, quadrangular only at the extremities of the young branches; eyes, medium prominent. The leaf is medium long and wide (mean length, 6 to 7.5 centimeters, or $2\frac{11}{16}$ to 3 inches, width, 1.25 to 1.75 centimeters, or $\frac{8}{16}$ to $\frac{11}{16}$ of an inch); superior surface, shining deep green; inferior, with thick deposit, principal nerve well marked on both faces. The leaves are very plentiful, forming a thick covering to the tree.

The fruit is regularly distributed along the entire length of the branches, most frequently single, sometimes in pairs; peduncle, short; pedicel, long, inserted in a well-marked depression on the berry; stigma, not apparent in well-marked umbilicus. This is an olive of under the medium size, or small. In California it is larger than in Europe; mean length in Europe is 1.5 to 1.66 centimeters, or $\frac{10}{16}$ to $\frac{11}{16}$ of an inch; width, 1.25 to 1.5 centimeters, or $\frac{8}{16}$ to $\frac{10}{16}$ of an inch. Its form is almost perfectly regular, with the exception that it is slightly obtuse at both extremities. The pit is large and of the same shape as the berry, with a groove along its entire length. The skin is of a shining, deep black color, rather thick, with very little bloom; pulp, abundant, of a white-red color.

Out of fifty-eight, six samples of this variety were received from the culture stations of the University; thirty-one different localities furnished the remaining fifty samples.

This variety of olive from Sacramento and San Joaquin Valleys, and of Southern California shows remarkable similarity in *oil content*, all ranging between 21 and 22 per cent. of oil in the flesh, or between 1 and 2 per cent. lower than the average (22.92 per cent.) for all localities. Those from the Foothill, Bay, and Southern Coast Range contain 25 to 26 per cent. of oil in the flesh, the Bay fruit showing the highest average amount, 26.04 per cent. In *size* there seems to be great regularity, with the exception of that of the Bay region which is the smallest, 215.9, and that from Sacramento Valley the largest, 136.9 olives per pound. In the fruit from the Sierra Foothills, the San Joaquin Valley, the Southern Coast Range, and Southern California, none vary to any extent from the average of all in size, *viz.*, 157 per pound.

With the exception of the Bay region fruit with 22 per cent. there is hardly any difference in *pit content* of the fruit of all the other regions, for the range is only between 16 and 17 per cent.; the average for all is 17.3 per cent.

When compared with the Nevadillo Blanco grown in France, that of California is found to be at least twice as large, and to contain only about four-fifths as much pit and nearly two-thirds more oil in the flesh. In Spain the variety attains much greater size, requiring only 90.4 olives to weigh a pound; we have no figures for its oil contents in other European countries.

The high yield of oil (the maximum for the common varieties) and its habit of regular bearing make the Nevadillo Blanco, as

raised on the varying soils of many different localities of California, one of the olives best adapted for oil making. Its size should make it as desirable for pickling as the Pendulina, Uvaria, Oblonga, and Rubra, but the Mission being larger, is considered better adapted for the purpose in question.

Manzanillo.

The Manzanillo is found throughout Spain and South France, where we are told it requires frequent regular pruning to insure regular crops. It ripens very early in the San Joaquin Valley, sometimes in October; but in the Bay region generally in November, though sometimes as late as January.

The tree is vigorous and hardy; the branches long, curved, and light colored. The secondary branches or twigs dry up when the fruit falls prematurely, which is frequent in Spain. The fruit is large and apple-shaped, sometimes slightly elongated.

The chief difference thus far noted between the various kinds of Manzanillos is that, in some cases, the apple-like depression at the lower extremity of the fruit is more marked than in others, otherwise there seems to be little real difference.

Thirty-eight samples of the variety have been examined here; of this number five were received from the culture stations. Taking the average for the several regions of the State, it is found that the fruit of the San Joaquin Valley, while the largest in size, 82.3 to the pound, and carrying the smallest pit, 11.7 per cent., has but little more oil than that from Southern California (16.55 per cent.) and a smaller amount (18.25 per cent.) than the fruit from the Bay region with 20.86, the Southern Coast Range with 21.10, or the Foothills with its 21.57 per cent.

The Foothill fruit is medium in size, 111.4 olives to the pound, that from the Bay region, being the smallest, averaging 141.3 per pound. There is some little difference in the pit-contents of these fruits, as they have respectively, 17.8 and 16 per cent.

The Southern Coast Range localities produce a small-sized fruit, 123.4, as compared with that from the San Joaquin Valley with 82.3, and that from Southern California, with 105.9 olives per pound. But in yield of oil the Southern Coast Range fruit is superior, showing in the flesh 2.9 per cent more than the Valley and 4.6 more than the Southern California Manzanillo.

The smallest Manzanillos, like the Missions, come from the Bay region, where upwards of 140 fruits of each of these varieties are necessary to make a pound. However, the Manzanillo contains only 20.86 as against 24.27 per cent of oil in the flesh of the Mission.

It appears, then, that for oil-making the Manzanillo from the Sierra Foothills reaches the best mark, and this upon a well-drained, light soil. It also seems to do fairly well for oil-making in the Southern Coast Range region, although the Mission olive excels it there by over 2 per cent. of oil, and in being at least one-fifth larger in size.

For pickling purposes the San Joaquin Valley Manzanillos are superior to all others in size; in pit content, or waste, they contain several per cent less than the others, and within about one-half of one

per cent. of that (11.11) reported for the Manzanillo in its native country (Spain). According to our experiments this olive should, after passing through the pickling process, retain in its flesh nearly as much nourishment (oil) as we have found in the fresh Manzanillo of the south.

Columbella.

[Sometimes called Columella, but Columbella seems to be the proper name.]

The Columbella was imported from France by John Rock, of Niles. The general form of the fruit is broadly oval, $\frac{14}{16}$ of an inch long and $\frac{11}{16}$ of an inch thick; very even in size, and remarkable for the peculiar pale yellow color that the fruit assumes before turning purple; pit small, $\frac{8}{16}$ of an inch long and $\frac{5}{16}$ of an inch in thickness, straight and sharp-pointed. The pulp in pickling seems to part with its tartness slowly, but when properly prepared has a delicious flavor. It ripens late, sometimes after the broad-leaved Mission.

Twenty-five samples of this variety have been examined, and of this number four have come from the culture stations of the University. The fruit from the San Joaquin Valley shows the highest average amount of oil in the flesh, 23.39 per cent.; the greatest departure from this being that found in the Sacramento Valley fruit which had only 14.94 per cent. of oil in the flesh. The analyses of Columbella from other regions show the following results: That from the Foothills average 22.78 per cent., the Bay region 21.61 per cent., from Southern California 21.37 per cent., and the Southern Coast Range 20.62 per cent. The southern fruit is the largest; the Southern Coast Range averaging 82.8 and the Southern California 92.8 olives per pound, both being over twice the size of the Bay fruit, which requires 163 olives per pound. The Sacramento, Valley, Foothill and San Joaquin Valley fruit range very close to the average for all, viz., 114 per pound.

For pickling, the chief use to which the Columbella is put, it seems to improve towards the southern districts, where, especially in the Southern Coast Range, it resembles the Valley Manzanillo in as far as its size goes. In localities south of Sacramento, it appears to be best adapted for oil making, although it is not as rich in oil as the Mission by about 3 per cent. on the average. Its oil, however, is of very good quality.

Rubra.

The Rubra was imported from France, by John Rock, of Niles. It is somewhat like the Mission in general appearance. Fruit ovate, slightly oblique, smaller than the Mission, $\frac{12}{16}$ of an inch long, $\frac{8}{16}$ of an inch thick; the pit straight, pointed, $\frac{8}{16}$ of an inch long and $\frac{4}{16}$ of an inch thick; maturity early, ripening from three weeks to one month earlier than the Mission; jet-black in color when allowed to hang on the tree. The tree begins to bear early and is quite prolific.

Out of thirty-five samples of this variety examined here, three lots were received from the University culture stations. It yields its highest average of oil, 28.47 per cent., in the Sierra Foothills; that from the Southern Coast Range averages 25.66 per cent.; from the the Bay, Valley and Southern California regions, the flesh of the fruit averages about 21.0 per cent. of oil, or just about 1 per cent. below

the average for all. The Sacramento Valley Rubras are, on the whole, the poorest in oil-bearing, showing only 18.07 per cent., but in size they stand second, equaling those from the Southern Coast Range, with 170.1 olives per pound. The largest fruit of this variety is produced in the San Joaquin Valley, where 156.3 olives make a pound. The average for all is 196.1. In the Bay region the Rubra is very small, averaging as many as 240.9 olives to the pound. By reference to the small table giving the variations between largest and smallest fruit, etc., it will be seen that the Rubra is not any more variable than most of the fully tested varieties.

The Rubra yields an oil of superior quality. Like the Manzanillo, it appears to be best adapted, for oil-making, to the well-drained soils of the Sierra Foothills. In the lower and richer lands of all the other regions, excepting the Coast Range, it does rather poorly, and in these places it never reaches the mark acquired by the Mission.

Redding Picholine.

The Redding Picholine was imported from France by the late B. B. Redding. It was imported for the large pickling olive known in France as the Picholine, and very highly esteemed there for that purpose, as well as for the small quantity of high-grade oil it yielded. For a long time it was supposed that the Redding Picholine was, after all, the true Picholine of Europe. Reference to the description of the true Picholine will show that this is an error, the first being very much smaller, as well as different in shape.

The olive is perfectly oval in shape, $\frac{8}{16}$ of an inch long and $\frac{4}{16}$ of an inch thick; it ripens early, several weeks sooner than the Mission; is dark purple or black in color. In pickling, the pulp looses its bitterness quickly, the fruit being pleasant to the taste.

Out of the forty-two samples of this variety examined, four have come from the culture stations of the University.

In production of oil, the Bay region fruit leads, as we find its flesh to contain an average of 24.43 per cent., the fruit from the other regions standing as follows: Foothill, 21.79; San Joaquin Valley, 21.47; Southern Coast Range, 21.63; Sacramento Valley, 19.51; Southern California, 17.82; the general average being 20.83 per cent. of oil in the flesh.

The largest specimens, on the average, have been received from the north of Sacramento, those from the Foothill region requiring 322.5 olives, and those from the former 341.1 olives to the pound. The Coast region fruit is by far the smallest, especially that from the southern part of the region, where as many as 452 olives are required to weigh a pound. The general average, 398.2 olives to the pound, is pretty closely followed by the Bay region with 416.8, the Southern California with 373.4, and the San Joaquin Valley with 353.3. The Foothill fruit contains the least pit, 20.8 per cent. Excepting this, the variations on either side of the general average—23.0 per cent. —are between one and two per cent.

Notwithstanding the rather abundant yield of oil shown by this variety from all over the State (only 1.6 per cent., on the average, less than the Mission) the fact that its oil is very poor in quality, and because of the extreme difficulty in keeping it clear and brilliant, it is

undesirable for oil-making. It is unsuitable for pickling, not alone because it is the smallest of all the commonly-grown olives, but also because it has such a large pit.

Having gained a place in the olive orchards of the State by being mistaken for the true Picholine of Europe, it only remains to speak of the use it may be made of, and this is best given perhaps in the following statement: "The tree is such an excellent grafting stock that it can be readily grafted into just as prolific varieties, which do not possess the same faults."

Picholine (True Picholine of Europe).

The tree is of medium vigor and dimensions, spreading grower; trunk, cylindrical; bark detaches easily from the trunk in regular strips; branches grow horizontally, or with a slight upward inclination; very few suckers; foliage, not vigorous, thick, growing at right angles to the main stem, of a yellowish gray color; wood, cylindrical, or slightly flattened; eyes, prominent.

Leaves oval, frequently wider at the upper part; medium length, and above medium width (5.5 to 6.5 centimeters in length, or $2\frac{3}{16}$ to $2\frac{10}{16}$ inches, 1.5 to 1.75 centimeters in width, or $\frac{10}{16}$ to $\frac{11}{16}$ of an inch; upper surface, dull deep green; lower surface, with slight dirty white pubescence; well marked nerves on lower surface; peduncle thick, long, straight. The leaf is flat at the edges. The young branches are heavily covered with leaves.

The fruit is generally accumulated near the lower part of the wood of the year, single or in bunches of two; pedicels, very short; stigma, persistent in a very slight umbilicus. The fruit is above the usual size (mean length 2.5 to 3 centimeters, or 1 inch to $1\frac{3}{16}$ inches; width 1 to 1.5 centimeters, or $\frac{6}{16}$ to $\frac{10}{16}$ of an inch. The form is ovoid and elongated, but thickest near the peduncle, coming to a point near the upper extremity. It is very much curved, of a form intermediate between that of the Lucques on one hand, and the Oliviere on the other. The fruit passes from a clear green to a reddish black; very little bloom, thin skin. Pit small, long, and pointed, being of the same shape as the fruit; maturity medium.

The true Picholine is widely known in France, especially in the neighborhood of Aix, Tarascon, and Marseilles, and throughout the Languedoc. It yields good crops with tolerable regularity. It is a variety of medium hardiness, but stands very heavy pruning. In France it is cultivated chiefly for pickles, although it yields a fair amount of high-grade oil. Its great delicacy makes it highly esteemed for pickles, which are generally sold under the name of Lucques. It and the Verdale are the best eating varieties of that country.

In California the general belief seems to be that the Picholine is the same variety as the Oblonga. There is certainly a strong resemblance between the two. Below we give all the comparative data at hand relating to the analysis of the Picholine of Europe and as grown in California; also the averages for thirty-two samples of Oblonga and forty-two of Redding Picholine:

Analyses of Picholines.

	Picholine.		Oblonga.	Redding Picholine.
	France.	California. (Average of two samples).	California.	California.
Number of olives per pound..	104.2	77.00	179.40	398.20
Pit, per cent.....	10.9	17.50	18.70	23.00
Oil, per cent. in flesh	17.0	21.18	15.88	20.83

From the above, it seems that there should be no confusion of the true Picholine with either the Oblonga, or the Redding Picholine. We find it here to be of the same size, grown at both extremes (northern and southern) of the regional limits of the olive, and with a difference of only four per cent. of oil in the flesh. As is to be expected, and shown above, the California Picholine is considerably larger than that grown in France, and yields, on the average, some four per cent. more of oil.

In size, the Picholine, with 77.0 olives per pound, rates favorably with the San Joaquin Valley (Fresno) Manzanillo, which requires 82.3 olives per pound. In quantity of oil in the flesh it leads these Manzanillos by almost three per cent., but in pit it falls behind, having more by 5.8 per cent.—just about the difference recorded above for the Picholines of France and California. Compared with the *Lucques* of California growth, our Picholine is over twice as large, and in nearly every case carries less pit. The only sample out of six Lucques which has more oil than the Picholine is that from Amador with 24.53 per cent. The Lucques is a variety frequently confounded with the Picholine, and is known mostly in Europe in localities where pickling is the chief industry.

The Picholine with us excels the *Verdale* in size, for it takes 114.5 olives of the latter, on the average, to weigh a pound. But the Verdale has a smaller pit and is higher in oil by one per cent in each case than the Picholine. The Verdale is a Languedoc variety found throughout France and highly esteemed for pickles.

The *Sevillano*, the largest olive examined here and one of the largest olives known, attains a size double that of the true Picholine; requiring only 36 as against 77 Picholine olives per pound, and this with a materially smaller pit. In oil content there is practically no choice between these two varieties. The Sevillano in Southern California grows to be as large as in Spain.

The records relating to these preëminently pickling varieties, while meagre, at least offer a sufficient reason for recommending them to the grower for more general trial.

Oblonga.

The Oblonga was imported from France by John Rock, of Niles. It is an olive of peculiar club-like shape, being narrow at the stem end, broad at the upper end, rounded and slightly oblique, $\frac{15}{16}$ of an inch long and $\frac{8}{16}$ of an inch thick. The pit is curved, $\frac{11}{16}$ of an inch long by $\frac{4}{16}$ of an inch thick, and generally pointed at both ends. The

pulp loses its tartness comparatively quickly in pickling, and is very pleasant to the taste; this recommends it especially as a pickling variety. It ripens at least two weeks earlier than the common broad-leaved Mission. Its color is dark purple. It is commonly supposed that the Oblonga is the same as the true Picholine of Europe, but there seems to be but little foundation for this belief, as the two varieties are quite distinct.

Thirty-two lots of this variety have been examined; out of this number five were from the University culture stations.

In oil the Southern Coast Range fruit leads, with an average of 19.05 per cent. in the flesh; but shows little advantage over the Southern California fruit which has an average of 17.99 per cent. Coming north into the San Joaquin Valley region, it is found that the oil content, 12.25 per cent., falls below that noted above. The olives of the Bay region and the Sacramento Valley both show higher contents of oil (respectively 16.48 and 15.64 per cent.) than the San Joaquin Valley; the general average is 15.68 per cent. The fruit is a little larger in the Sacramento region than in the San Joaquin Valley or in Southern California, the figures being respectively 135.9, 142 and 154 olives per pound; from the Bay region 212, and from the Southern Coast Range 193.5 olives are required for a pound. There is little variation in pit content in the fruit from the different regions; the average being 18.7 per cent.

Although the quality of this oil is very good, this variety is not at all well adapted to the Great Valley region for oil-making; and at best is not more than medium for the purpose. For pickling the Valley fruit would be the best if size were alone considered, but its low oil-content would not indicate a very nourishing product; therefore, all things considered, the Oblonga from the south would appear to be the best. It has the reputation of having a delicately flavored flesh. One of its peculiarities seems to be that the volume of the flesh diminishes very much during the process of pickling; so that when pickled, the precentage of pit seems to be greater than that indicated by analysis.

Uvaria.

The Uvaria was imported by John Rock from France. The fruit is oval, regular, and rounded at both ends, $\frac{13}{16}$ of an inch long and $\frac{9}{16}$ of an inch in thickness; pit straight and heavy, $\frac{10}{16}$ of an inch in length and $\frac{6}{16}$ of an inch in thickness. It ripens later than the common Mission olive; color is dark purple or black when ripe. The name, "grape-like" is well chosen, the fruit growing in clusters, as many as seven together and resemble the grape in shape. The Uvaria is very prolific.

Twenty-nine samples of this variety have been examined at this laboratory; of these, three were grown at the University culture stations. The Foothill, Southern California and Bay fruits each average 20.5 per cent. of oil in the flesh; Sacramento Valley and Southern California fruits both average 17.5 per cent., and that in the San Joaquin Valley, 15.4 per cent. of oil; the average for the Uvaria from all localities is 18.51 per cent. The largest fruit comes from the Southern Coast Range, 133.6 olives to the pound, the smallest from

the Bay region where 258.9 olives weigh a pound; in the other regions the general average is 205.1 olives per pound. In pit content the Uvaria exceeds all other common varieties, carrying 8 per cent. more than either the average Mission or Nevadillo.

Its low yield of oil in the San Joaquin Valley would mean that it is a poor variety for oil-making there, and even where it does its best, it never comes up to the Mission.

Pendulina.

The Pendulina was imported by John Rock from France. The fruit is of an even oval shape, rounded at both ends, quite variable in size, many fruits remaining small and undeveloped; it is $\frac{12}{16}$ of an inch long and $\frac{9}{16}$ of an inch thick; the pit $\frac{7}{16}$ of an inch long, $\frac{4}{16}$ of an inch thick, exclusive of the small, sharp points often found at both ends. The fruit grows in clusters of two to five; the pulp parts very readily with its tartness. This variety must not be confounded with the Pendoulier, which is somewhat larger and more of an ovate shape.

Twenty-two samples of this variety have been tested; five from the culture stations of the University. For oil-making the Pendulina is found to reach its best in the southern part of the State, where it averages 23.0 per cent. of oil in the flesh. In the San Joaquin Valley it apparently does not produce a high amount of oil, giving only 18.21 per cent. on the average, which is considerably less than is yielded by the fruit from the Sacramento Valley (21.88) and Southern California (22.11).

For pickling, the Southern California-grown Pendulina is the best, because of its size; but in this it falls much below the southern Mission, for 141.3 are required to make a pound, while only 100.2 of the Mission are necessary.

Razzo.

The Razzo is mainly cultivated in the Province of Lucca and Pisa, together with Mignolo, Moraiolo, and Grossaio. The fruit is roundish, fleshy, and contains more oil (in Italy) than any of the native Italian varieties, on which account it is called by the peasants "frantoiano," or oil-press olive. The Razzo commences to ripen in November or December. The soils that suit it best are those that are deep, rich, and well-drained. It suffers from the cold, fog, and winds of the lowlands, prefering the protected hillsides. Though it is exceptionally fertile, it drops its fruit very readily, especially when exposed to winds or prolonged hot spells.

In California this fruit, from seven widely separated localities (from Central to Southern California) shows the highest average yield of oil, 32.82 per cent., from the Santa Clara Valley; at Pomona it averages 30.30; in the Sierra Foothills, 26.76; and at Tulare, in the Great Valley, it produces only 23.48 per cent. of oil. The general average of ten samples is 28.48 per cent. of oil in the flesh. Like most of the Italian varieties grown here, it averages in size about one-half that of the Mission; but it contains more pit than the latter, carrying 24.3 per cent.

As compared with the *Grossaio*, grown in the Santa Clara Valley, the Razzo produces a little less oil, 1.50 per cent. on the average,

while Pomona-grown Grossaio falls below the average Razzo some 5.0 per cent. in oil.

The *Cucco* averages at Santa Barbara 34.0 per cent. of oil in the flesh, or 1.3 per cent. more than the best Razzo, *i.e.*, that of the Santa Clara Valley. At Pomona, the Cucco, with 31.7 per cent. and the Razzo, with 30.5 per cent., appear to be very much alike in oil production. In the Santa Clara Valley it does poorly, averaging only 21 per cent.

The *Corregiolo*, at Santa Barbara, averaged, for four different seasons, 32.52 per cent. of oil, a figure very similar to that of the Razzo at its best in California. In the Santa Clara Valley it produces 24 per cent., while at Tulare, in the Great Valley, it attains but 18.81 per cent. of oil.

The *Leccino*, a hardy Tuscan variety, which produces in its native home a low-grade oil—one hard to clarify and of inferior taste—gives its highest yield of oil, 35.12 per cent., at Santa Barbara, the average being 30 per cent. Other southern localities, Pomona and Orange, show nearly 31 per cent. of oil. In the North it falls below this some five per cent., carrying but 26 per cent. of oil.

As far as the record goes, these Italian varieties, away from the Great Valley and especially on the low mesa soils where they have received the most attention, give great promise of becoming of high importance for oil-making. Generally, they yield oil of the highest quality; which should also commend them to the grower for more general and extensive trial.

Variation in Size of Fruit, Amount of Pit and Oil.

The following table shows the variation in size, amount of pit and oil in the flesh in some of the common varieties of olives. The figures are so arranged as to indicate the relative differences between minimum and maximum with regard to size, amount of pit and percentage of oil in the flesh, in each variety, the minimum being the unit.

Ratio of Smallest to Largest Fruit, Pit and Oil in the Flesh.

Variety.	Size of Fruit.	Amount of Pit.	Oil in Flesh.
Mission	1:4.0	1:2.1	1:2.5
Nevadillo Blanco	1:3.7	1:1.9	1:2.4
Manzanillo	1:3.9	1:2.5	1:2.7
Redding Picholine	1:2.4	1:2.0	1:3.9
Columbella	1:4.0	1:2.0	1:2.2
Pendulina	1:2.0	1:2.1	1:3.1
Rubra	1:3.1	1:1.4	1:2.9
Uvaria	1:2.8	1:2.0	1:2.5
Oblonga	1:3.0	1:1.9	1:4.3
Atro-violacea	1:1.7	1:1.8	1:3.5
Praecox	1:3.5	1:1.5	1:2.5
Atro-rubens	1:2.7	1:1.6	1:1.7
Polymorpha	1:2.5	1:1.4	1:2.2
Nigerina	1:4.2	1:2.8	1:1.7
Regalis	1:2.6	1:1.7	1:1.9

From whatever cause these variations arise, lack of harmony of the variety with its locality, or the insufficiency of analytical data, it is a

difficult matter, if not an impossible one, to name the variety which, on the whole, presents the least variations. For example, the best known variety, the Mission, shows comparatively great variation in size of fruit and only medium variation in oil and pit. The Redding Picholine, on the other hand, reverses the order of variation, and shows a greater variation, comparatively, in the matter of oil-bearing, than in the quantity of pit or size of fruit.

The selection of proper varieties for planting in California is thus shown to have received as yet only a part of the careful attention that the question demands. The necessity for, and the importance of, the work undertaken by the Station in bringing out and presenting all the various characteristics is forcibly shown.

The table of averages by varieties, page 34, gives the number of samples, the size of the fruit, the pit content, and the per cent. of oil in the drupe, flesh, and pit of the various olives examined in the Station laboratory. This summary, together with the foregoing record, will afford a guide to the more intelligent use of the detailed record of analyses already in the hands of the interested grower, when studying varieties and making selections suitable to his soil, location, and climate.

In reviewing the record relating to the Mission, Nevadillo Blanco, Redding Picholine, Uvaria, Manzanillo, Oblonga, Rubra, Columbella, and Pendulina, there are sufficient data to warrant the statement that *these varieties as grown in the Bay region are all of smaller size than those from any of the other regions of the State, but generally they bear the largest percentages of oil*—in some of them the average is even higher than those of the same varieties in the Sierra Foothills. It would seem, then, that the cool bay climate does not affect the proper functioning of the drupe of these varieties.

In the Sacramento Valley on the north and in Southern California on the south, these olives have about the same size and the same richness in oil, showing that the climatic influences of the two sections are about alike; and that the natural moisture in the northern soils offsets that furnished by irrigation in the south. The Southern Coast Range fruit has a more even distribution of the qualities in question, for it produces a fairly large fruit with more oil. In size, the San Joaquin Valley olives (excepting the Manzanillo, the largest fruit of those named,) may be said to resemble the Southern California fruit; with a tendency, on the whole, to yield less oil.

The records of analyses of the olives of the unusually dry season of 1894–95 show that this fruit was poor in size and quantity of oil. The results of the work upon the olives of the present season will undoubtedly furnish some additional interesting information in regard to the influence of a dry season upon the olive. The work will, of course, not be as extensive as formerly, for the reason that many complaints of "failure of crop" reach the Station this year.

AVERAGES BY OLIVE VARIETIES.

VARIETY.	Number of Samples Examined.	Size, Number of Olives Per Pound.	Pit, per cent.	PER CENT. OF OIL.		
				In Whole Fruit.	In Flesh.	In Pit, referred to whole fruit.
Varieties Fully Tested.						
Mission	112	111.6	17.2	17.56	22.51	.61
Nevadillo Blanco	57	157.3	17.3	19.21	22.92	.99
Manzanillo	38	106.6	14.7	16.94	19.73	.55
Redding Picholine	42	398.2	23.0	16.18	20.83	1.52
Uvaria	29	205.1	25.5	13.71	18.51	1.07
Rubra	35	196.1	17.9	18.58	22.01	.75
Oblonga	32	179.4	18.7	13.34	15.68	.85
Columbella	25	114.6	16.6	15.59	19.54	.60
Pendulina	22	157.1	13.7	18.63	21.36	.96
Varieties not yet Fully Tested.						
Atro-violacea	19	206.6	22.5	17.55	22.40	1.08
Praecox	15	196.1	19.2	14.34	17.75	.84
Polymorpha	14	71.9	17.1	15.85	18.82	.88
Macrocarpa	12	72.8	17.5	14.70	20.41	.70
Salonica	9	166.2	16.1	20.04	23.60	.55
Regalis	12	112.5	16.3	16.37	19.58	.96
Nigerina	12	160.0	17.5	19.96	26.16	1.06
Atro-rubens	11	115.4	16.9	19.14	25.59	.75
Corregiolo	11	262.7	25.8	21.15	27.68	1.24
Razzo	10	216.5	24.3	21.10	28.42	.84
Frantoio	7	298.9	25.9	24.10	33.94	1.00
Morinello	8	287.9	23.1	21.60	28.90	1.00
Cucco	8	192.9	21.1	27.22	34.38	.70
Leccino	7	245.5	21.7	22.45	28.50	.95
Piangente	5	308.0	21.4	16.71	21.16	.86
Grossaio	6	242.3	25.7	23.96	32.78	1.03
Palazzuolo	5	272.1	22.2	29.34	37.70	.67
Morchiaio	4	238.2	23.0	29.34	37.99	.36
Infrantoio	1	375.0	30.0	19.31	27.58	
Moraiolo	3	333.4	33.0	21.74	32.22	1.45
Lavignano	4	239.6	24.2	24.28	31.90	
Mignolo	1	227.0	12.0	16.50	18.70	
Lucques	6	192.9	23.0	14.81	17.21	1.09
Pleureur de Grasse	7	171.2	18.5	22.04	26.65	.74
Verdale	5	114.5	16.7	19.05	22.53	.65
Picholine	2	77.0	17.5	17.83	21.18	.72
Ascolano	5	60.6	12.0	16.26	18.45	.57
Caillon	2	178.5	20.0	16.95	21.19	
Obliza Pendulier	1	176.3	20.0	12.33	15.41	
Obliza	5	105.2	14.6	11.23	13.42	.37
Amellau	4	120.0	16.5	15.67	16.51	.59
Amygdalina	2	76.9	15.0	19.90	23.41	
Empeltre	3	111.4	15.7	19.86	22.93	.75
Hervaza	3	197.0	15.0	14.39	17.22	.37
Bella di Spagna	2	151.4	22.5	18.75	23.94	
Huff's Spanish	2	425.8	25.0	16.50	21.99	.99
Olea Maria	2	194.7	20.5	17.85	22.83	.77
Sweet Olive	3	213.9	15.3	12.04	13.96	
Bellamonte	2	157.1	20.0	17.74	20.30	
Dalmatian	2	120.0	17.5	15.92	18.92	.63
Ascoli	2	113.2	16.0	16.89	19.72	.54
"Queen"	2	140.1	24.0	27.67	36.30	
Santa Caterina	5	100.1	18.2	17.91	20.09	.52
Sevillano	2	36.2	14.5	17.23	20.19	.40
Attica	1	176.3	20.0	15.91	19.79	
Olivastro	2	160.4	25.0	21.55	28.79	
Rufa	2	219.2	17.0	20.36	24.54	
Evatella	1	162.7	17.0	23.85	28.73	

1 2 3

THE OLIVE KNOT

1.—Small knots on under side of leaves.

2.—Large knots on small branch, as commonly seen on vigorous trees when first attacked.

3.—Knot on leaf-stalk.